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Contract No.

T - 967DRL No.

Item No.

DRD No. Vought Rpt. No.: MA -384T 221RPN0533

NAS9-14476

CR 151185

(NASA-CR-151185) REINFORCED CARBON CARBON (RCC) OXIDATION RESISTANT MATERIAL SAMPLES -BASELINE COATED, AND BASELINE COATED WITH TETRAETHYL ORTHOSILICATE (TEOS) IMPREGNATION Final Report (Vought Corp., Dallas, Tex.) G3/24

N77-18216

Unclas 16349

FINAL REPORT FOR

Reinforced Carbon Carbon (RCC) Oxidation Resistant Material Samples - Baseline Coated, And Baseline Coated With Tetraethyl Orthosilicate (TEOS) Impregnation

Dated

7 January 1977

Submitted To

The National Aeronautics and Space Administration Johnson Spacecraft Center Houston, Texas



VOUGHT CORPORATION P. O. Box 5907 Dallas, Texas 75222

Contract No. NAS9-14476

DRL No. T-967

Item No. 3

DRD No. MA-384T Vought Rpt. No.: 221RPN0533

# FINAL REPORT FOR

Reinforced Carbon Carbon (RCC) Oxidation
Resistant Material Samples - Baseline Coated,
And Baseline Coated With Tetraethyl
Orthosilicate (TEOS) Impregnation

Dated

7 January 1977

Submitted To

The National Aeronautics and Space Administration Johnson Spacecraft Center Houston, Texas

Written By: E. E. Jan

E. E. Gantz

Test Project Engineer -

LESS

Approved By:

G. B. Whisenhunt

Program Manager - LESS

VOUGHT CORPORATION
P. O. Box 5907
Dallas, Texas 75222

Report No. 221RPN0533 Page 3

#### ABSTRACT

This report presents a description of the program for: (1) the fabrication of Reinforced Carbon Carbon (RCC) oxidation resistant plasma arc, combined environment and mechanical properties specimens for evaluation by the NASA, and (2) the silicon carbide coating of six NASA heater elements. The specimens provided included both baseline coated specimens as well as baseline coated/Tetraethyl Orthosilicate (TEOS) impregnated specimens.

All of the specimens were fabricated and processed in accordance with specification procedures accepted by the prime Shuttle Contractor for the fabrication and processing of the Leading Edge Structural Subsystem (LESS) elements for the Space Shuttle Orbiter.

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## 1.0 INTRODUCTION

This program was initiated by Vought Corporation on 2 December 1974 under Contract NAS9-14476. The program objective was twofold: (1) to provide Reinforced Carbon Carbon (RCC) material samples both baseline coated and baseline coated, Tetraethyl Orthosilicate (TEOS) impregnated for evaluation by the NASA Lyndon B. Johnson Space Center, and (2) to silicon carbide coat six NASA heater elements for evaluation by the Lyndon B. Johnson Space Center.

The (RCC) specimens were machined from 19 and 33 ply flat panels which were fabricated and processed in accordance with the specifications and procedures accepted by the prime Shuttle Contractor for the fabrication and processing of the Leading Edge Structural Subsystem (LESS) elements for the Space Shuttle Orbiter. The specimens were then baseline coated and TEOS impregnated, as applicable, in accordance with the procedures and requirements of the appropriate LESS production specifications.

Three heater bars were ATJ graphite silicon carbide coated with the Vought "pack cementation" coating process, and three were Stackpole Grade 2020 graphite silicon carbide coated with the chemical vapor deposition process (CVD) utilized by Vought in coating the LESS shell development program entry heater elements.

#### 2.0 PROGRAM MATERIAL SUMMARY

The end items of this contract are the test samples and materials as specified in Paragraph 3.0 of the contract statement of work. A summary discussion of the items delivered with regard to the appropriate statement of work requirement follows:

#### 2.1 RCC Baseline Coated Test Specimens

By Paragraph 3.1 of Reference (a), "a minimum of 130 RCC baseline coated specimens shall be supplied in a configuration mix of 1.0 in. to 3.0 in. diameter discs, and 0.8 in. x 2.8 in. to 1.4 in. x 6.5 in. bars. The specimens are to be fabricated from thin ply (19 ply) and thick ply (38 ply) panels. Approximately 10 of the 3.0 in. diameter discs are to be instrumented with three thermocouples each."

A total of 130 specimens were fabricated and shipped to the NASA in the configuration mix as outlined in Table 1.0, page 7. Table 1.0 also presents the specimen serial numbers and identifies the NASA center to which the various specimens were shipped.

As will be noted, additional specimen configurations were included and the specimen configuration mix varied somewhat from the requirements specified in Paragraph 3.1 of Reference (a). These adjustments were discussed with the NASA Technical Monitor on 13 May 1975 in a telephone conversation with Mr. E. E. Gantz of Vought.

Copies of the shipping papers for these specimens are the Certification Reports are presented in Enclosures (1) and (2).

#### 2.2 Coated Graphite Heater Elements

Paragraph 3.2 of Reference (a) states, "The Contractor shall apply the 0.020 in. thick oxidation inhibited coating to the following (GFE) graphite heater elements: (a) six carbon strips, 29.875 in. x 1.850 in. x 0.136 in., (b) six carbon blocks, 1.375 in. x 1.75 in. x 0.875 in., and (c) six carbon pins, 5/16 in. diameter x 0.25 in."

Subsequent Vought experience in coating graphite indicated that Speer 890S graphite is not a suitable graphite for the Vought silicon carbide "pack cementation" coating process, and that ATJ graphite is the optimum graphite substrate for this process. Based on experience in coating the shell development program entry thermal heater bars, Vought strongly recommended that NASA coat their heater bars with the silicon carbide chemical vapor deposition coating.

TABLE 1.0
RCC SPECIMEN SUMMARY

Specimen Quantity	Specimen Part No.	Specimen Configuration	Specimen Gerial Numbers	Remarks
RCC Basel	ine Coated Specimen	ns		
2	221GT4027	Lug Specimen	9-7 and 9-8	Shipped to NASA/JSC
18	221GT4027	l in, Dia Disc	7-37, 7-38, 7-39, 7-40, 7-29, 7-30, 7-31, 7-32,	Shipped to NASA/JSC
			7,33, 7-35, 7-36, 7-41, 7-42, 7-43, 7-44, 7-45, 7-46, 7-52	
4	221GT4027	l in.x 5 in.Flex Bar	4-5-1, 4-6-1, 4-7-1, and 4-35	Shipped to NASA/JSC
9	221GT4027	l-1/2 in,x 6 in. Flex Bar	2-11, 2-26, 2-31, 6-35, 6-36, 6-37, 6-38, 6-39 6-48	Shipped to NASA/JSC
23	221GT4027	2.8 in. Dia Disc	3-18-1, 3-19-1, 3-20-1, 3-21-1, 3-48, 3-50, 3-51, 3-54, 3-55, 3-56, 3-57,	Shipped to NASA/JSC
			3-58, 3-59, 3-60, 3-61, 3-62, 3-63, 3-64, 3-65, 3-66, 3-67, 3-68, 3-69	
6	221GT4066	1 in, x 6 in. Flex Bar	032-022, 033-022, 033-024, 033-025, 033-026, 033-027	Shipped to NASA/JSC
3	221GT4066	2.8 in. Dia Disc	033-011, 033-009, 033-010	Shipped to NASA/JSC
11	221GT4066	l,5 in. Dia Disc	033-029, 033-030, 033-031, 033-032, 033-033, 033-034,	Shipped to NASA/JSC
			033-035, 033-036, 033-037, 033-038, 033-039	
	221GT4066	l in, x l in, Square	032-046, 032-047, 032-048, 032-049, 032-050, 032-051, 032-052, 032-053, 032-055, 032-056, 032-056, 032-056, 032-066, 032-064, 032-066, 032-067, 032-066, 032-067, 032-068, 032-067, 032-071, 032-075, 032-076, 032-071, 032-080, 032-081, 032-082, 032-083, 032-084, 032-086, 032-089, 032-089, 032-089, 032-089, 032-089, 032-089, 032-089, 032-089, 032-089, 032-0994, 032-062	Shipped to NASA/JSC
* 1	221GT4066	6 in. x 12 in. Panel	031-001	Shipped to NASA/JSC
6	221GT4066	l in.x 6 in.Flexure Bar	032-013, 032-014, 032-017, 032-018, 032-019, 032-021	Shipped to NASA/Langle
6	221GT4066	2.8 in. Dia Disc -	031-002, 031-003, 031-004, 031-006, 031-007, 031-008	Shipped to NASA/JSC
RCC Basel	ine Coated, TEOS I	mpregnated Specimens		
20		2,8 in. Dia x 33 Ply RCC Disc	3-18-1, 3-19-1, 3-20-1, 3-21-1, 3-40, 3-48 3-50, 3-51, 3-56, 3-58, 3-59, 3-61, 3-62, 3-63, 3-64, 3-65, 3-66, 3-67, 3-68, 3-69	Shipped to NASA/JSC
2		1.5 in.x 6.5 in. x 33 Ply RCC Flexure Bar	2-11 and 2-26	Shipped to NASA/JSC
10		1.5 in.x 6,5 in.x 19 Ply RCC Flexure Bar	2-1-1, 2-2-1, 2-7, 2-8, 2-9, 2-10, 2-33, 2-34, 2-35, 2-36	Shipped to NASA/JSC
18		2.8 in. Dia x 19 Ply RCC Disc	3-14-1, 3-19, 009, 011, 3-13, 3-14, 3-15, 3-17, 3-70, 3-71, 3-72, 3-73, 3-74, 3-76, 3-77, 3-78, 3-80, 3-81	Shipped to NASA/JSC
9	221GT4067	NASA Mass Loss Specimens-19 Ply	NO39P-1 thru N039P-9	Shipped to NASA/JSC
9	221GT4067	NASA Mass Loss Specimens -33 Ply	NO40P-1 thru NO40P-9	Shipped to NASA/JSC

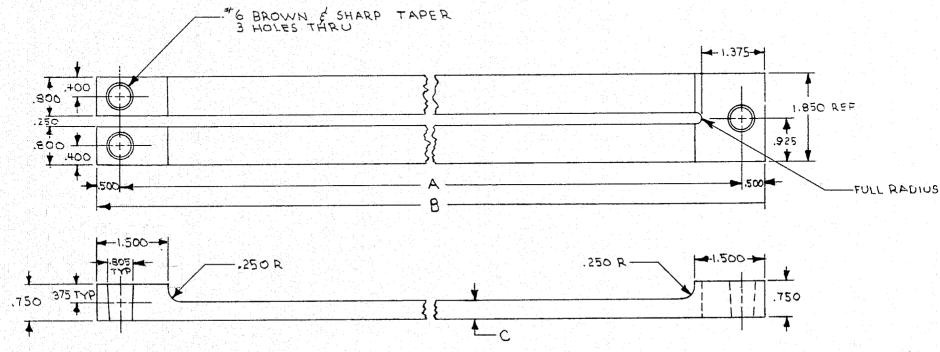
ORIGINAL PAGE IS OF POOR QUALITY To gather data with which to substantiate the predicted characteristics of the "pack cementation", a coating system on Speer 890S graphite, NASA delivered two heater elements to Vought which were cut into small specimens and coated. The coating thickness was very irregular - the coating disappearing completely at the corners of the specimens. The coating bond to the graphite was also extremely fragile and the graphite had eroded severely in the areas of coating discontinuity.

Based on these test data, it was agreed with the NASA Technical Monitor that the existing NASA heater bars would not be coated with the Vought silicon carbide "pack cementation" process as specified in the contract. Instead, three NASA (-5) configuration heater bars (Figure 1.0, Page 9), of ATJ graphite would be silicon carbide coated with the Vought "pack cementation" process, and three (-5) configuration bars of Stackpole Grade 2020 graphite would be silicon carbide coated with the chemical vapor deposition process by the Materials Technology Corporation of Garland, Texas. Vought would supply the graphite to NASA/JSC, NASA would machine the elements, and Vought would be responsible for coating the bars. The length of the bar would be limited to 28 in. maximum by the diameter of the Materials Technology Corporation coating reactor. The CVD applied coating thickness would be 0.010 in. applied in two 0.005 in. passes. The bar supports would be repositioned for the second pass to preclude pin holes through the coating at the support points.

NASA completed machining of the six bars to the NASA (-5) heater bar configuration and shipped them to Dallas on 4 December 1976. One bar was fractured at Materials Technology Corporation during coating. The failure was reported to the NASA technical monitor. He instructed Vought to ship the bar "as is".

The bars were coated and shipped to NASA/JSC on 27 January 1976. Copies of the shipping papers are presented in Enclosure (3).

On arrival of the six bars at NASA/JSC, all were broken. As replacements, Vought machined 2 additional bars of Stackpole graphite Grade 2020, had them CVD coated by Materials Technology Corporation, and "hand carried" them to NASA/JSC on 13 April 1976.



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FIGURE 1.0

NASA/JSC HEATER ELEMENT.

# 2.3 NASA Mass Loss Specimens - RCC Baseline Coated and TEOS Impregnated

By Paragraph 3.1.6 of Reference (a), "18 specimens shall be supplied to the configuration shown in Figure 2.0, page 11. Nine shall be cut from one 12 in.  $\times$  16 in.  $\times$  33 ply panel, and 9 shall be cut from a 12 in.  $\times$  16 in.  $\times$  19 ply panel. The specimens shall be baseline coated and TEOS impregnated."

The specimens were shipped to NASA/JSC on 21 December 1976. Copies of the shipping papers, and the Certification Report are presented in Enclosure (5).

#### 2.4 RCC BASELINE COATED AND TEOS IMPREGNATED TEST SPECIMENS

By Reference (b), the contract statement of work was revised with the addition of Paragraph 3.3 to the TEOS impregnation of 50 RCC baseline coated specimens. The specimens were to be government furnished in the following mix.

- a. 20 3" diameter disc (33 ply)
- b. 18 3" diameter disc (19 ply)
- c. 10 1 1/2 in. 6 1/2 in. bar (19 ply)
- d.  $2 1 \frac{1}{2}$  in.  $\times 6 \frac{1}{2}$  in. bar (33 ply)

The TEOS was to be applied using the same processes defined in specifications accepted by the prime Shuttle Contractor.

The specimens were received on 5 October 1976, TEOS Impregnated, and shipped to NASA/JSC on 7 December 1976. Copies of the shipping papers and certification documentation are presented in Enclosure (4). The specimens are identified by configuration and serial number in Table 1.0, page 7.

# NASA RCC MASS LOSS SPECIMEN

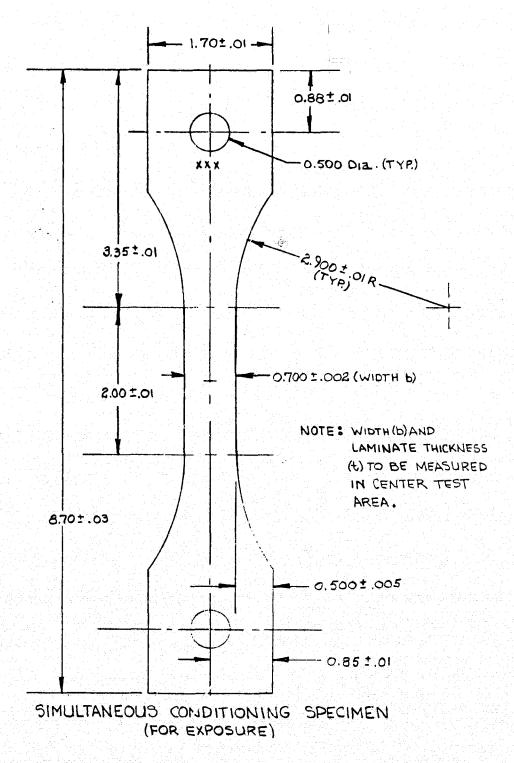


FIGURE 2.6

#### REFERENCES

- (a) Exhibit A Statement of Work, "Reinforced Oxidation Resistant Carbon-Carbon (RCC) Material Samples and Graphite Heater Elements", dated 2 December 1974.
- (b) Revision of Exhibit A Statement of Work, "Reinforced Oxidation Resistant Carbon-Carbon (RCC) Material Samples and Graphite Heater Elements", dated 2 September 1976.

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1.0 RCC SPECIMEN SUMMARY

# LIST OF FIGURES

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2.0	NASA RCC MASS LOSS SPECIMEN	11	
	CONFIGURATION		

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## ENCLOSURE (1)

TEST SPECIMEN SHIPPING PAPERS

AND CERTIFICATION DOCUMENTS - RCC

BASELINE COATED TEST SPECIMEN®

CONTRACT NAS9-14476

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NASA COATED CARBON TEST SAMPLES

DOCUMENTATION PACKAGE

CONTRACT NAS9-14476

Enclosure (1) to Report

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VOUGHT SYSTEMS DIVISION LTV AEROSPACE CORPORATION P. O. BOX 5907 DALLAS, TEXAS 75222

This certifies that the RCC test specimens listed herein conform to the requirements of Contract NAS 9-14476 with the exceptions noted in the Deviation Summary.

Test reports and acceptance data are on file and are subject to examination on request.

G. F. Bentinck

Quality Program Manager Leading Edge Structural

Subsystem

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2	Table of Contents
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4	Test Data Summary
5	Deviation Summary
6	Serial Number Listing

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#### NONDESTRUCTIVE TEST RESULTS

RCC specimens included in this shipment have been subjected to radiographic examination and ultrasonic inspection per Process Specifications 208-7-40 and 208-7-41 and accepted.

Coating thickness has been verified by eddy current technique and has been accepted with deviations noted in Deviation Summary.

Enclosure (1) to Report

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Page: 8 of 20

## TEST DATA SUMMARY

• FLEX TEST

As coated 14,247 - 14,731 psi

Furnace cycled 13, 100 - 15, 705 psi

REQUIRED

13,000 psi min.

13,000 psi min.

FURNACE CYCLE % WEIGHT CHANGE

-.06 to +.30 percent

-1% max.

• PLASMA TEST MASS LOSS

.78 to 1.61  $\times$  10<sup>-5</sup> lbs. ft. sq.

 $4.0 \times 10^{-5} \text{ max.}$ 

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# **DEVIATION SUMMARY**

- 1. Specimens 014-2-26, 014-4-6-I, and 026-6-36 do not have .03 radius on edges (LDS 65063).
- 2. Specimens have spots in coating and/or discoloration of coating (LDS 63837, 63842, 63840).

S/N	S/N	<u>s/n</u>
014-2-26	017-3-60	026-7-36
2-31	3-61	7-37
4-6-I	3-63	7-39
6-48	3-64	7-42
7-52	026-2-11	7-45
015-9-7	6-35	
9-8	6-36	
016-3-48	6-37	
3-50		
3-54		원을 들어 없음을 살았다.
3-55		

- 3. Ink markings came through coating (LSD 63837).
- 4. Temperature lagging time requirements of specification during coating cycle (LDS 63833).
- 5. Specimens 015-9-7 and 015-9-8 have coating thickness to .044 in. Exceeds spec. max. of .040 in. (MRA 043694).

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# SERIAL NUMBER LISTING

PNL 014	PNL 015	PNL 016
2-26 2-31 6-48 4-6-I 4-7-I 4-35 7-52	4-5-I 9-7 9-8	3-48 50 51 54 55 56
PNL 017	PNL 026	
3-18-I 19-I 20-I 21-I 57 58 59 60 61 62 63 64 65 66 67 68 69	2-11 6-35 36 37 38 39 7-29 30 31 32 33 35 36 37 38 39 40 41 42 43 44 45	
	45 46	

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	.,		STORES RE			ORDER NO.	1	
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6 ea.	221GT 4066		l In. x	6 In. F	lexure Bars -	Ser. Nos.:	N/A	N/A
					<b>033-</b> 026			
					033-027			
3 ea.	221GT 4066		2.8 In.	Dia. Di	ses (Un-instr	umented)	N/A	N/A
			Serial	Nos.:				
					033-010			
			033-	009				
	1		2 8 Tn	Dia. Di	ses (Instrume	rted)	N/A	N/A
<del>- 5 68</del>	221GT 4066						W 14/12	[ IV/A
<del>- 5 88</del>	<del>221GT 4066                                  </del>		Serial				1	N/A
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Enclosure (1) to Report No: 221RPN0533 Page: 12 of 20

Request for Shipment RFS-RCC-79

Date \_\_11 July 1975

(Continued)

Contr. Item	Qty.	Part No.	Description	Unit Price	Total Amount
5	41 ea.	221GT 4066	1 In. x 1 In. Squares - Ser. Nos.:  032-046 032-061 032-082 032-047 032-064 032-083 032-048 032-065 032-084 032-049 032-066 032-086 032-050 032-067 032-087 032-051 032-068 032-088 032-052 032-069 032-089 032-053 032-071 032-090 032-055 032-072 032-091 032-056 032-075 032-092 032-057 032-076 032-093 032-058 032-078 032-094 032-059 032-080 032-062 032-060 032-081	N/A	N/A
6 7		221GT 4066 221GT 4066	6 In. x 12 In. Panel - Ser. No. 031-001 Quality Control NDE and Test Logs and Certification Report	n/a n/a	n/a n/a

Enclosure (1) to Report

No: 221RPN0533 Page: 13 of 20

NASA TEST SPECIMENS

DOCUMENTATION PACKAGE

CONTRACT NAS9-14476

Enclosure (1) tp Report

No: 221RPN0533 Page: 14 of 20

VOUGHT SYSTEMS DIVISION LTV AEROSPACE CORPORATION P. O. BOX 5907 DALLAS, TEXAS 75222

This certifies that the RCC test specimens listed herein conform to the requirements of Contract NAS9-14476 with the exceptions noted in the Deviation Summary.

Test reports and acceptance data are on file and are subject to examination on request.

F. J. Patterson

Quality Program Manager Leading Edge Structural

Subsystem

Enclosure (1) to Report No: 221RPN0533 Page 15 of 20

# TABLE OF CONTENTS

PAGE	
1	Certification of Compliance
2	Table of Contents
3	Statement of Nondestructive Test Results
4	Test Data Summary
5	Deviation Summary
6	Serial Number Listing

Enclosure (1) to Report

No: 221RPN0533 Page: 16 of 20

# NONDESTRUCTIVE TEST RESULTS

RCC specimens included in this shipment have been subjected to radiographic examination and ultrasonic inspection per Process Specification 208-7-40 and 208-7-41 and accepted.

Coating thickness has been verified by Eddy Current technique and has been accepted with deviations noted in Deviation Summary.

Enclosure (1) to Report No: 221RPN0533 Page 17 of 20

# TEST DATA SUMMARY

	ACTUAL	REQUIRED	
• FLEX TEST			
As coated	12638 PSI	12042 PSI minimum	
Furnace cycled	13147 PSI	11133 PSI minimum	
• FURNACE CYCLED % WEIGH	HT CHANGE		
-0.39 to -0.90 Percent	-1% maximum		
• PLASMA TEST MASS LOSS			
1.62 to 2.39 x $10^{-5}$ lbs.	ft. sq.	4.0 x 10 <sup>-5</sup> maximum	

Enclosure (1) to Report

No: 221RPN0533
Page: 18 of 20

#### DEVIATION SUMMARY

- 1. All specimens have darker color, brownish, on mold side than normal (Ref. LDS #72977).
- 2. 1.5" dia. discs S/N #033-045 has white ditto mark on bag surface .3" long (Ref. LDS #72965).
- 3. Specimens S/N's 033-35 and 033-36 have coating thickness below specification limit. Thickness should be .020 .040. Specimens measure:

033-35

.019 mold side

.024 bag side

033-36

.019 mold side

.025 bag side

Reference MRA 0053542.

Enclosure (1) to Report

NO: 221RPN0533 Page: 19 of 20

#### SERIAL NUMBER LISTING

1 In. x 6 In. Flexture Bars - Serial No.'s:

032-022
033-026
033-027
033-024
033-025

2.8 In. Dia. Discs (Uninstrumented) - Serial No.'s:
033-011
033-009

1.5 In. Dia. Discs - Serial No. 's:

033-029
033-035
033-030
033-031
033-037
033-032
033-038
033-033
033-034

1 In. x 1 In. Squares - Serial No. 's: 032-046 032-061 032-082 032-047 032-064 032-083 032-048 032-065 032-084 032-049 032-066 032-086 032-050 032-067 032-087 032-051 032-068 032-088 032-052 032-069 032-089 032-053 032-071 032-090 032-055 032-072 032-091 032-056 032-075 032-092 032-057 032-076 032-093 032-058 032-078 032-094 032-059 032-080 032-062 032-060 032-081

6 In. x 12 In. Panel - Serial No.:

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						<i>A</i>		441.1
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* 1	- 1	1			1 /1021	isenhunt	WITH AER. S.P	7722
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LTY	- 1	LTV CUST	LTV	CUST LT	G. B. Wr.	FOR SHIPP	NATURE 2-16000 UNIT	7722
LTY	CUST	LTV CUST	LTV	CUST LT	G. B. Wr.	FOR SHIPP	NATURE 2-16000 UNIT	7722

Enclosure (2) to Report

No: 221RPN0533 Page: 1 of 9

# ENCLOSURE (2)

TEST SPECIMEN SHIPPING PAPERS AND
CERTIFICATION DOCUMENTS - RCC BASELINE
COATED TEST SPECIMENS.

NAS 9 - 14476

INSPECTION LAYOUT PRESERVATION PACKING  INSPECTION SIGNATURE  INSPECTION LAYOUT PRESERVATION PACKING  INSPECTION LAYOUT PRESERVATION PACKING  INSPECTION SIGNATURE  INSPECTION LAYOUT PRESERVATION PACKING  INSPECTION SIGNATURE  INSPECTION LAYOUT PRESERVATION PACKING  INSPECTION SIGNATURE  INSPECTION SIGNATURE  INSPECTION SIGNATURE	2 of 9	G REQUEST G MEMO IEMO	No: 221RP	n	Division Corporate 75222	space 5907 Texas	V Aero O. Box llas,	LT P. Da cer son Spa	ASSIFIED HANDLING On Office Johns	CONFIG Nun-cla Modified H CK ONE Mortatio	DENTIAL - N CHEC Transp NASA L	□ TOP:     □ SECR     □ CONF     □
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Enclosure (2) to Report No: 221RPN0533 Page: 3 of 9

NASA TEST SPECIMENS DOCUMENTATION PACKAGE CONTRACT NAS9-14476

Enclosure (?) to Report No: 221RFN0533 Page: 4 of 9

VOUGHT SYSTEMS DIVISION
LTV AEROSPACE CORPORATION
P.O. BOX 5907
DALLAS, TEXAS 75222

This certifies that the RCC test specimens listed herein conform to the requirements of Contract NAS9-14476 with the exceptions noted in the Deviation Summary.

26 August 1975

Test reports and acceptance data are on file and are subject to examination on request.

F. J. Patterson

Quality Program Manager Leading Edge Structural

Subsystem

Enclosure (?) to Report No: 201RPN0533

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1.	Certification of Compliance
2.	Table of Contents
3•	Statement of Nondestructive Test Result
4.	Test Data Summary

Deviation Summary

Serial Number Listing

OF POOR QUALITY

5.

6.

No: 221RPN0533
Page: 6 of 9

### NONDESTRUCTIVE TEST RESULTS

RCC specimens included in this shipment have been subjected to radiographic examination and ultrasonic inspection per Process Specification 208-7-40 and 208-7-41 and accepted.

Coating thickness has been verified by Eddy Current technique and has been accepted.

Enclosure (2) to Report No 221RPNC533 Page: 7 of 9

# TEST DATA SUNMARY

ACTUAL	REQUIRED
FLEX TEST	
As coated 12638	
	Mininum
Furnace cycled 13147	PSI 11133 PSI Minimum
FURNANCE CYCLED % WEIGHT CHANGE	
-0.39 to -0.90 Percent	-1% Maxim
PLASMA TEST MASS LOSS	
1.62 to 2.39 x 10 <sup>-5</sup> lbs. ft. sq.	4.0 x 10 Maximum

No: 221RPN0533
Page: 8 of 9

### DEVIATION SUMMARY

1. All specimens have darker color, brownish, on mold side than normal (Ref. LDS #72977).

No: 221RPN0533 Page: 9 of 9

#### SERIAL NUMBER LISTING

# 2.8 In. Dia. Discs (Instrumented)

031-002

031-003

031-004

031-005

031-006

031-007

031-008

Enclosure (3) to Report No: 221RPN0533 Page: 1 of 2

ENCLOSURE (3)

SHIPPING PAPERS -SILICON CARBIDE COATED NASA HEAT ELEMENTS CONTRACT NAS 9 - 14476

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Enclosure (4) to Report No: 221RPN0533 Page: 1 of 18

# ENCLOSURE (4)

SHIPPING PAPERS AND CERTIFICATION DOCUMENTS - RCC BASELINE COATED AND TEOS IMPREGNATED TEST SPECIMENS

CHARGE	ECRET [ST PRINCE   Park   Park	Officer With: Purcha Contracted to: D.	Vought Co Systems I P. O. Bo Dallas, T s & Space T er 058 ability Proper 807402 se Req. No. 4 et No. NAS9-1 J. Tillian, ESI	Division x 5907 exas 75222  DATE 7 Dece  YOUR INVOICE D  ty -266-020 4476 1, Bldg. 420	RETURNI RETURNI REPAIR REPAIR REPAIR REPAIR MISCELL	No: 221 Page: 2 SHIPPING SHIPPING DEBIT M  76 NUMBE  AMOUNT  ED FOR CREE DOR REWORK A DOR REWORK A DOR REPLACE ANEOUS (EXF	RECONT AND REPLANT OUR EXPENSIONS ENTOUR EXPENSI	C-119  CEMENT CPENSE E OBY GUARANTEE Specimens
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No: 221RPN0533 Page: 5 of 18

NASA TEST SPECIMENS

CERTIFICATION REPORT

CONTRACT NAS9-14476

**REPORT NO. 221RPN0526 9 DECEMBER 1976** 

P. O. BOX 5907

DALLAS, TEXAS 75222

Enclosure (4) to Report

No: 221RPN0533 Page: 6 of 18

This document certifies that the GFE RCC specimens listed herein have been TEOS impregnated in accordance with Specification procedures accepted by the prime Shuttle Contractor as required by Contract NAS9-14476.

Test reports and acceptance data are on file and are subject to examination on request.

E. E. Gantz

Test Project Engineer

Leading Edge Structural Subsystem

9 December 1976
Date

No: 221RPN0533 Page: 7 of 18

### TABLE OF CONTENTS

### PAGE

- 1. Certification Of Compliance
- 2. Table Of Contents
- 3. Nondestructive Test Results
- 4. Test Data Summary
- 5. Specimen Serial Number Summary

No: 221RPN0533 Page: 8 of 18

#### NONDESTRUCTIVE TESTS RESULTS

The TEOS impregnated, baseline coated RCC specimens, covered by this document have been checked for conformance with the process controls, NDE test requirements, and coating performance requirements as defined in the TEOS Impregnation Process Specification, 208-7-42 and meet the appropriate requirements as stated.

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Enclosure (4) to Report No: 221RPN0533 Page: 9 of 18

# TEST DATA SUMMARY

Paragraph of Spec 208-7-42	<u>Item</u>	Required	Actual
4.2.8(b)	Control Specimen Weight  Gain - 19 Ply Flex Bar	4.7% to 8.0%	4.99% to 7.25%
5.6.1.3	Control Specimen Tube	<0.041 lb/ft <sup>2</sup>	.028 $lb/ft^2$ max.

-(0)

No: 221RPN0533 Page: 10 of 18

### SPECIMEN SERIAL NUMBER SUMMARY

1. 20 ea - 2.8 in. Dia x 33 ply RCC Disc - Baseline Coated and TEOS Impregnated

2. 2 ea - 1.5 in. x 6.5 in. x 33 ply RCC Flexure Bar - Baseline Coated and TEOS Impregnated

2-11 2-26

3. 4 ea - 2.8 in. Dia x 19 ply RCC Disc - Baseline Coated and TEOS Impregnated

3-14-1 3-19 009 011

4. 10 ea - 1.5 in. x 6.5 in. x 19 ply RCC Flexure Bar - Baseline Coated and TEOS Impregnated

2-1-1 2-8 2-33 2-36 2-2-1 2-9 2-34 2-7 2-10 2-35

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No: 221RPN0533 Page: 13 of 18

NASA TEST SPECIMENS

CERTIFICATION REPORT
CONTRACT NAS9-14476

REPORT NO. 221RPN0528

17 DECEMBER 1976

Enclosure (4) to Report No: 221RPN0533 Page: 14 of 18

P. O. BOX 5907

DALLAS, TEXAS 75222

This document certifies that the GFE RCC specimens listed herein have been TEOS impregnated in accordance with specification procedures accepted by the prime Shuttle Contractor as required by Contract NAS9-14476.

Test reports and acceptance data are on file and are subject to examination on request.

6. 6. Jone E. E. Gantz

Test Project Engineer Leading Edge Structural

Subsystem

Deamber 1976

Enclosure (4) to Report No: 221RPN0533

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2	Table Of Contents
3	Nondestructive Test Results
4	Test Summary
5	Specimen Serial Number Summary

Enclosure (4) to Report No: 221RPN0533

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#### NONDESTRUCTIVE TEST RESULTS

The TEOS impregnated, baseline coated RCC specimens covered by this document have been checked for conformance with the process controls, NDE test requirements, and coating performance requirements as defined in the TEOS Impregnation Process Specification, 208-7-42, and meet the appropriate requirements as stated except that the tube furnace mass loss of both control specimens exceeds the maximum allowable specification value of 0.041 lb/ft<sup>2</sup>.

The excessive control specimen mass loss is not considered to be indicative of unacceptable TEOS impregnation, however, since the percentage weight gain of these 14 specimens during the TEOS processing agreed closely with the weight gains experience with the other 36 specimens in the impregnation run. The indicated excessive tube furnace mass loss is considered rather to reflect a deficiency in the control specimen substrate only. No specimens of the actual specimen substrate lot were available so the control specimens were selected from another substrate lot which was adjudged to be similar.

To confirm the acceptability of the specimen TEOS impregnation, one specimen (Serial No. 3-13) was subjected to the tube furnace check, and demonstrated mass loss well within specification requirements.

No: 221RPN0533

Page: 17 of 18

## TEST DATA SUMMARY

Paragraph of Spec. 208-7-42	<u>Item</u>	Required	<u>Actual</u>
4.2.8(b)	Control Specimen Weight  Gain - 19 Ply Flex Bar	4.7% to 8.0%	6.64% to 6.69%
5.6.1.3	Control Specimen Tube Furnace Mass Loss	0.041 lb/ft <sup>2</sup>	0.056 lb/ft <sup>2</sup> max
5.6.1.3	Specimen Number 3-13 Tube Furnace Mass Loss	0.041 lb/ft <sup>2</sup>	0.029 lb/ft <sup>2</sup>

Enclosure (4) to Report No: 221RPN0533 Page: 18 of 18

## SPECIMEN SERIAL NUMBER SUMMARY

- 1. 3-13
- 2. 3-14
- 3. 3-15
- 4. 3-17
- 5. 3-70
- 6.3-71
- 7. 3-72
- 8. 3-73
- 9. 3-74
- 10. 3-76
- 11. 3-77
- 12. 3-78
- 13. 3-80
- 14. 3-81

Enclosure (5) to Report NO: 221RPNO533

Page: 1 of 4

SHIPPING PAPERS AND CERTIFICATION

DOCUMENT - NASA MASS LOSS SPECIMENS, RCC

BASELINE COATED AND TEOS IMPREGNATED

CONTRACT NAS 9 - 14476

TOP	FIDENTIAL - M CHEC Nation Adm Johns 1720 Houst  Mark  Mark	Officer 807 With: Purchase F	Vought Corp P. O. Box 5 Dallas, Tex Space 7 Dallas, Tex Space 7 Lity Property 402 Req. No. 4-2 o. NAS9-144	6907 as 75222  TE 21 De  DUR INVOICE	Cember    RETUR   RETUR   RETUR   REPAIR	Report Page: 6 Shippin Shippin DEBIT	DIT DIT AND REPLAT VENDOR'S AT OUR EXPER	PN0533  RCC -121  EC. REPORT  ACEMENT EXPENSE	
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Enclosure (5) to Report No: 221RPN0533 Page: 4 of 4

8

VOUGHT CORPORATION
P. O. BOX 5907
DALLAS, TEXAS 75222

This certifies that the RCC test specimens listed below have been manufactured, inspected and tested to the applicable Vought process specifications and requirements of contract NAS9-14476.

12/23/1976

Test data for mechanical properties and non-destructive testing is on file.

s/n no39p-1	<u>L</u>	s/n	NO40P-1
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F. J. Patterson

Quality Assurance Manager

LESS Program

22 December 1976

/mlm

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OF POOR QUALITY

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